AUTOMATION OF INDUSTRY

by

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Jan. 5
1955

AUTOMATION OF INDUSTRY

EXCITEMENT in industrial circles over the potentialities of automation—a word so new that it is not to be found in most dictionaries—is beginning to spill over to the general public. Installation by an increasing number of enterprises of automatic processes and automatic controls of startling capacities has engendered widespread publicity about human machines and robot factories. It has led also to widespread speculation on the social and economic consequences of extensive use of the labor-saving and time-saving devices which are involved in the development called "automation." [1]

The accelerating trend toward automation has prompted talk of a second industrial revolution. The first industrial revolution, it has been pointed out, replaced manual labor by machines; the second will replace manual control by machine control. The new industrial revolution will turn over to instruments tasks that formerly had to be performed by the human mind, just as the first industrial revolution relieved the human body of certain physical tasks. Whereas the first revolution mechanized manufacturing processes, the second will make them automatic.

At the heart of the second industrial revolution lies man's "ability to create machines that can perform the functions of control and data processing—as well as the heavy labor of our society." [2] It is the ability to build such machines—plus the economic and technical incentives to automate industrial operations—that has speeded the trend toward automation. The extent of the spread in utilization of automatic control equipment is evidenced by the fact that, ac-

[1] The word itself is said to have been coined, independently of each other, by John Diebold, then a student at the Harvard Graduate School of Business Administration and now editor of *Automatic Control*, and by D. S. Harder, vice president of the Ford Motor Company. Other terms used to describe what is coming generally to be called automation include advanced mechanization, automatic control, automatic feedback control, automaticity, automatism, and automatization.

[2] John Diebold, "Automatic Control: Today's Industrial Revolution," *Automatic Control*, July 1954, p. 7.

cording to a survey last summer by *Automatic Control* magazine, sales of such equipment rose from a value of around $1 billion in 1949 to an estimated $3 billion in 1954.

Definitions of Automation; Concept of Feedback

Automation has nearly as many definitions as it has advocates. It has been described most simply as "the operation of machines by other machines rather than by human hands." [3] The term may be used to refer to anything from mere mechanized handling of materials to the kind of automatic process in which all phases of production, manufacture, assembly, and inspection are carried out—through use of automatic controls—without human assistance or with a minimum of such assistance.

D. S. Harder, vice president of the Ford Motor Company, has defined automation as employed by Ford as "the automatic handling of parts between progressive production processes." [4] A broader definition has been given by W. E. Brainard of the Hughes Aircraft Company: "Automation is a philosophy of design, . . . a manufacturing method, and . . . control within a machine." [5] Automation engineers emphasize that automation involves more than "hardware."

Common to the various forms of automation is the concept of automatic feedback control or self-correction. Such application of the principles of self-regulation to the manufacturing process is fundamental to an automated process. Although definitions of automation differ, it is agreed that feedback is basic to the concept. Norbert Wiener of the Massachusetts Institute of Technology, a pioneer in the field of automatic control, has defined feedback as "the property of being able to adjust future conduct by past performance . . . a method of controlling a system by reinserting into it the results of its past performance."[6]

The most frequently cited example of feedback is the common furnace thermostat. That device is so contrived that, when the temperature of the room goes above or below a pre-set level, the fuel supply to the furnace is cor-

[3] *New York Times* report (Nov. 16, 1954, p. 41) of meeting of American Standards Association.

[4] Quoted in *C.I.O. News*, Sept. 13, 1954. Other Ford spokesmen have noted that automation equipment "physically ties two producing machines together and completely handles the material between them."—"Answers to 13 Key Questions About Automation," *Factory Management and Maintenance*, December 1952, p. 107.

[5] Quoted in *Production*, February 1954.

[6] Norbert Wiener, *The Human Use of Human Beings* (1954), pp. 33, 61.

respondingly reduced or increased. In other words, information about performance is fed back into the mechanism to correct operation and to achieve the desired result. "A feedback system not only obtains specified results, it *modifies* its operations as required to obtain those results." [7]

Human Qualities of the New Automatic Machines

Spread of automation in industry and speculation on the possibility of devising completely automatic operations have led to frequent references to the human qualities of the new automatic machines. This has been especially true of descriptions of such automatic control devices as the giant electronic computers. Often spoken of as "brains," these machines have been described as possessing the ability to ask and answer questions, think, and make decisions. The modern computer, "most sophisticated expression of automatic control," has been called the first machine to approach the "generalized abilities of a human being." [8]

Although electronic computers have capacities that seem to resemble human mental processes, they are essentially no more than complicated counting machines. Computers and other automatic control devices make yes-or-no decisions but only decisions based on instructions given to them in advance. The only choices open to them are based on built-in and alterable instructions. But once machines equipped with automatic feedback controls have been "programmed" or "taped" (that is, instructed), they can perform complex operations without human intervention.

Application of Automation in Various Industries

Automation has been applied successfully to a variety of operations in a number of industries, and it is likely that many other operations will be automated in the not distant future. However, there is no place for automation in some industries; in others, conversion to automatic operation may cost more than it is worth. Up to now, for example, it has been deemed economically impractical to attempt to make steel production—with the exception of continuous casting —entirely automatic.

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[7] Alan Bloch, "Feedback Systems: A Basis for Self-Regulation," *Automatic Control*, July 1954, p. 17.

[8] Louis N. Ridenour, "The Role of the Computer," *Scientific American*, September 1952, p. 117. Ridenour suggested that the computer might better be called an "information machine . . . to distinguish its function from that of a power machine, such as a loom."

The oil and chemical industries are the most highly automated. Automation has made long strides there, not only because fluids and gases lend themselves to such handling more readily than do solid materials, but also because they require a type of regulation which automatic controls can perform more satisfactorily than human operators. Also contributing to the high degree of automation in the oil and chemical industries is the fact that they are continuous-process industries, in contrast to the automobile industry with its discontinuous, step-by-step, assembly-line operations.

At a *Fortune*-sponsored round-table discussion of the automatic factory, reported in the October 1953 issue of the magazine, R. J. Emmert of General Motors said that automation could be applied most easily "to any series of operations which can be sequentially determined ahead of time." Yet the assembly line has shown great resistance to automation. Manipulation problems and the many variables involved are blamed.

Experts have pointed to a great need for automatic equipment that can load and unload work pieces, transfer products from machine to machine, and lift, turn, and position units of different sizes. The Ford Motor Company two years ago solved many of those problems at its engine plant near Cleveland. Machine tools there were linked into groups and the groups linked together, so that all the machines operate as a unit. With this set up, about 4,000 engine blocks are made daily from rough castings on a line 1,545 feet long, composed of 44 automatic machine tools and 80 automation units which perform 530 boring, broaching, drilling, honing, milling, and tapping operations with little human assistance. The Pontiac Motor Division of General Motors, late in 1954, put into operation an automated piston-manufacturing line that is said to turn out about 2,000 units an hour. Throughout the entire process, the pistons move on belts and through chutes without being touched by a worker's hands.

Some indication of the range of industries where automation already is playing a role, or eventually will do so, is given by reference to a classification prepared by Richard L. Meier of the University of Chicago, who is an authority on industrial planning and economic development. Among the industries where advanced design now aims at fully

automatic facilities, Meier listed—in addition to chemicals and liquid fuels—cement and brick, fermentation products, synthetic fertilizer, paper products, soap, and telecommunications. Industries whose facilities will become largely automatic but which may still utilize manual skills include fiber and textile, glass and ceramics, iron and steel, machine-tool, mining and processed foods. Finally, industries "tending to become mechanized in the traditional manner, thus depending upon skilled operators" include transport, forestry and wood products, garment, and shipbuilding.[9]

Evolution and Potentialities of Automation

DEVELOPMENT of the theories and devices which made automation possible was sporadic up to within the last 10 or 15 years. Although some feedback systems were in use nearly 200 years ago, until fairly recent times the perfection of automatic mechanisms depended upon the ingenuity of the inventor rather than upon any wide or continued research. It has been only in the last decade or so that progress in electronics, communication and control theory, and electric-network analysis has been sufficient to permit contruction of a large variety of self-correcting machines. Mathematical formulation in the 1940s of the theory of communication and control by Claude E. Shannon of the Bell Telephone Laboratories and others, together with work done during the war on radar and gun directors, speeded the evolution of automation and brought nearer a realization of its potentialities.

Early Types of Automatic Controls and Machines

The earliest authenticated examples of feedback control devices and automatic machines in industry appeared around the middle of the 18th century. In 1741, Jacques de Vaucanson, a French inventor, constructed a mechanical silk loom, the pedals of which were automatically controlled by means of a drum pierced with holes. On this side of the Atlantic, in 1784, Oliver Evans built near Philadelphia a continuous-process flour mill that required no human labor from the time the grain was received until it was processed

[9] Richard L. Meier, "Automatic and Economic Development," *Bulletin of Atomic Scientists*, April 1954, p. 130.

into flour. Four years later, to regulate the speed of his steam engine, James Watt invented the flyball governor—usually regarded today as the ancestor of modern, complex feedback devices. Joseph Jacquard improved on de Vaucanson's loom in 1804 by perfecting the Jacquard loom, whose operations were controlled by a punched paper roll similar to that in the player piano.

Forerunners of today's electronic computers appeared even earlier than the Vaucanson loom. The French mathematician, Blaise Pascal, built a half-dozen *machines arithmétiques* in the mid-1600s, and other computers were developed in the following century. A calculating machine comparable to modern computers was the "difference engine" designed in 1823 by Charles Babbage, an English mathematician; however, technical difficulties, including the inferior machining methods of the time, prevented Babbage from actually building his calculator. Just before the turn of the century, Herman Hollerith of the U. S. Census Bureau anticipated modern data-processing devices when he developed punch-card machinery to analyze the national census data of 1890. Late in the 1920s, Vannevar Bush, who was to head the government's science activities in World War II, developed with his associates a differential analyzer which was the first of the large-scale computing machines.

Impetus of World War II and Industrial Demands

The military demands of the Second World War provided the stimulus and brought forth the funds needed to solve formidable scientific problems with dispatch. Out of wartime research on radar and fire control came much of the technology of automation. Tracking and shooting down fast-flying enemy planes required computation of many variables at speeds beyond human capacity and made old gun-laying techniques obsolete. Consequently, automatic feedback control systems were needed for gun directors and for radar and other devices as well. In addition, military needs spurred development of the electronic digital computer, a refined version of which is expected to serve ultimately as the master control device for fully automated operation.

One aspect of wartime research that hastened development of automatic controls was the practice of pooling the abilities of many different specialists. The aid thus given

to furthering the technology of automation has been described by Gordon S. Brown and Donald P. Campbell of the Massachusetts Institute of Technology:

> The specialists of engineering and science found themselves talking to one another for the first time in generations. Mechanical engineers exploited techniques of circuit theory borrowed from the communications engineers; aeronautical engineers extended the use of electrical concepts of measurement and of mathematical presentation; mathematicians working with engineers and experimental scientists discovered entirely unsuspected practical uses for forgotten theorems. The enforced collaboration soon focused attention on the essential principles that apply to all control systems.
>
> The general theory of control systems which now emerged was enriched in turn with the lore of experience from many different technologies. With the theoretical means at hand to write the equations for motors, amplifiers, and hydraulic transmissions, it became possible to design control-system components with entirely new properties to meet predetermined needs.[10]

The increasing complexity of modern industrial technology in itself gave strong impetus to automation. In most industrial operations the human operator used to control a machine or a process by reading an instrument and making whatever correction or adjustment was required; in effect, the operator served as the feedback link. But as technology grew more complicated, men could not make the decisions as rapidly as the processes required. As a result, instruments which formerly had merely measured and indicated had to be given the additional task of control. The growing need for automatic controls in the oil- and chemical-processing industries in the past two decades is an example of the industrial requirements which stimulated interest in feedback systems.

Necessity for Redesign of Production in Future

Now that the basic technology of automation has been evolved, engineers, scientists, and planners have turned their attention to its wider application. And they have come to realize that the problem of automatic production frequently involves more than mere attachment of new automatic control devices to old machines. Even where this is possible, it does not represent the optimum use of automation.

In many cases it has been found that not only the old

[10] Gordon S. Brown and Donald P. Campbell, "Control Systems," *Scientific American*, September 1952, p. 59.

machines but also the whole manufacturing process—even the product itself — may have to be redesigned. Engineers planning to automate a factory have been specially warned that it is "highly important . . . not [to] think of automatic production as a process of automatically duplicating the hand motions of present machine operators." [11] Such an assumption might lead not only to inefficiency but also to the conclusion that certain operations could not be automatically controlled, whereas redesign might make automation entirely practical.

A frequently cited example of a product redesigned for automatic production is the "printed" radio circuit. In this case, spraying, stamping, or plating conducting material on a ceramic or plastic plate, rather than wiring and soldering many small components together by hand, made possible the automatic production of radio circuits. Redesigning a whole element is not always necessary. In some cases a minor change, such as casting a small nipple on the side of a container, may facilitate automatic control of an operation.

Perhaps the best example of a process redesigned for automatic production is the changeover from batch processing to continuous processing in the oil-refining and chemical-manufacturing industries. Redesigning the manufacturing process so that the oil and chemical products were no longer processed one vat and one step at a time made it possible to introduce an automatic system.

Redesign of machinery may be required to avoid the complexity and inefficiency of a Rube Goldberg-like contraption limited to duplicating hand-and-arm motions. Charles Hautau, a leading exponent of automation, wrote in the July issue of *Automatic Control* that "True automation requires . . . the design of one machine which will perform *all* operations." Redesign may be necessary also in order to obtain a machine versatile enough to make a few items each of many different kinds of products rather than many copies of a single product. Most current automatic production machines are single-purpose machines, but large-scale automation will require machines flexible enough to make a number of different parts or products.

Such custom-built machinery is apt to be very costly. But

[11] John Diebold, "Automation—The New Technology," *Harvard Business Review*, November-December 1953, p. 66.

J. J. Brown and E. W. Leaver, two Canadian pioneers in automation, maintained in the *Fortune* round-table discussion in 1953 that converting to automatic production need not be prohibitively expensive if the operation rather than the product was kept uppermost. In other words, production should be analyzed in terms of the operations common to various production processes (cutting, drilling, etc.) rather than in terms of the steps that are carried out at present in non-automated operations. Automation experts of the Ford Motor Company have observed that "You need engineers who think of all the ways you can automate, not why you can't automate." [12]

Possibilities for Automation in Business Offices

Full automation of the office is thought by some observers to be nearer at hand than complete automation of the plant. Office automation already has appeared on a limited scale in forms ranging from automatic reservations-handling systems employed in some cities by the Pennsylvania Railroad and by American Airlines to electronic data-processing systems used by the Metropolitan and Franklin Life Insurance companies The American Telephone and Telegraph Company reportedly is almost ready to institute a coast-to-coast subscriber dialing system under which automatic accounting and billing machines will relieve operators of making tabulations on long-distance calls.

Assistant Commerce Secretary James C. Worthy disclosed last November that a score of federal agencies were working with the Bureau of Standards on plans to utilize electronic devices to reduce the government's paper work. An advisory committee headed by Vannevar Bush, reporting to Secretary of Commerce Weeks on Dec. 28, recommended concerted efforts to develop electronic machines for patent searching. Such machines would drastically cut down the time required for that task and enable the Patent Office to avoid current long delays on patent applications—delays that may stretch into years and seriously handicap industrial development.

Electronic computers already are in use at the Census Bureau, the Weather Bureau, the Atomic Energy Commission, and the Defense Department. The recently delivered Naval Ordnance research calculator, to be used on guided

[12] "Answers to 13 Key Questions About Automation," *Factory Management and Maintenance*, December 1952, p. 105.

missile, sub-surface projectile, and other problems, makes the most complex computations in millionths of a second and is said to be able to do more calculating in a day than a thousand human beings could do in a lifetime.[13]

Automation of paper work, it has been suggested, may well be the development in electronics that will have the most revolutionary impact on business. In comparison with materials handling in the factory, materials handling in the office is a minor problem for designers of automation equipment. And builders of the giant electronic computers assert that such machines are destined to become the most powerful management tools yet devised.

The experience of the few companies using the newest large computers seems to bear out that prediction. W. S. Smith, senior procedures analyst of General Electric's Louisville appliance division, which has installed a Univac computer, told a conference sponsored by the American Management Association on Oct. 20 that the electronic computer could give management information never before available. "With a computer," said Smith, "the accounting function, which has been primarily historical, can supply more than a rear-view mirror; it can provide a clear windshield and even some ability to see around the corner." Smith believed that in the future it would be possible for a company to have a master plan—combining electronic sales forecasting, budgeting, and production control—which would enable it to put out the right product at the right time, place, and price, and at the lowest possible cost.

Proposed Use of Automation in Undeveloped Areas

One use of automation which may seem startling but which has received serious attention from respected economists and planners is the automating of certain basic manufacturing industries in underdeveloped countries. Adherents of such proposals point to oil refineries in the Near East and the recently built fertilizer plant at Sindri, India, as successful examples. Wassily Leontief of Harvard has stated, "Instead of trying to lift the whole economy by the slow painful methods of the past, an industrially backward country may take the drastic shortcut of building a few large, up-to-date automatic plants." [14]

[13] Meyer Berger in *New York Times*, Dec. 10, 1954, p. 29.

[14] Wassily Leontief, "Machines and Man," *Scientific American*, September 1952, p. 160.

Richard L. Meier of the University of Chicago, who has made intensive studies of problems of social adaptation to technological changes, feels that automated plants can do much more than rural industries or primitive factories to promote the advance of underdeveloped areas. He says this is particularly true in the case of such populous countries as China, India, and Pakistan, and of countries whose economies rest largely on mineral exports, such as Iraq and Chile. "The reasons for choosing automation," Meier has written, "stem not only from its greater efficiency but also from the smaller demands that are made upon the factors of production which are continuously in short supply during the period of rapid economic development." [15]

Automation makes smaller demands on both capital and labor. Meier points out that the limited capital available for investment in underdeveloped regions must be allocated to undertakings which yield the largest returns. Automation would obviate any need to make heavy drains on capital funds for housing and auxiliary installations, for no large numbers of workers would be required. Growth of industry thus would not encourage extensive migration to the cities, and "dislocation of the economy would be reduced." Instead of the large number of technical and white-collar employees usually needed—and usually not available in underdeveloped countries—only a comparatively small force of skilled and semi-professional workers would be called for in automated plants. As for management and engineering personnel, there is said to be a greater shortage of the type of engineer who can run a primitive factory than of the type trained in advanced technical processes.

Economic and Social Effects of Automation

THE possible social effects of widespread application of automation in industrial plants and business offices have caused nearly as much anxiety as the astonishment caused by the envisioned economic effects. Despite the relative newness of automation, its social and economic significance has been widely debated. Fear that it will lead to extensive technological unemployment has grown with each new

[15] Richard L. Meier, "Automatic and Economic Development," *Bulletin of Atomic Scientists*, April 1954, p. 131.

application. The most worried observers see every man displaced by automation as a permanent addition to the ranks of the jobless; the most hopeful see few or no new unemployed.

Advantages of Automation to Industry and Labor

Higher productivity and increased production, reduced operating costs, less waste, better-quality products, and safer operation are benefits that industry expects to reap from automation. Output may be increased not only because automated equipment is more efficient than manual labor, but also because the production equipment can conceivably be operated without pause through all 168 hours of the week. Greater efficiency in turn reduces operating costs, as does the elimination of certain jobs and the wage payments that go with them.

Some idea of the time and labor-saving advantages attributed to automation is given by comparing data on the Ford Motor Company's production of engine blocks by nonautomated and by automated methods. In the former case an engine block was said to require nine hours to pass from its rough cast stage to its completely assembled stage; with automation, the whole process takes about 15 minutes. Drilling oil holes in crankshafts, which used to be done by 29 machines and 39 men, now requires only three machines and nine men. Finally, automation has been credited by Ford spokesmen with having improved quality and made for safer operation.

Advantages of automation have been reported by the Admiral Corporation in manufacturing television receivers. Use of electronically controlled equipment to assemble a printed-circuit television chassis has boosted production and also has resulted in greater engineering flexibility and lower costs, according to John B. Huarisa, Admiral's executive vice president. Advantages of automatic operation in the clerical field have been demonstrated by the Metropolitan Life Insurance Company's use of an electronic computer that is reported to have replaced 100 punch-card machines and 135 operators. In still another field an electronic yardmaster, installed last October at the Union Pacific Railroad's classification yard at North Platte, Neb., automatically switches and couples freight cars. And it carries out this operation with such precision that damage to cars and cargo by human error is eliminated.

Perhaps the greatest advanage of automation is that it will bring in new products and new services. Automatic control permits the carrying out of processes, such as the production of nuclear materials, that could not be undertaken if it were necessary to rely on manual controls. "Actually," John Diebold wrote in the first issue of *Automatic Control* last July, "the truly revolutionary qualities of this new movement are found in the new markets it is opening and the industries that are expanding with it."

Biggest advantage of automation to labor, it has been argued, is that it will free workers from subordination to the machine. Individuals will be released from drudgery to take up tasks allowing fuller exercise of their talents. As a result of the greater productivity of automated equipment, moreover, workers will have considerably more leisure.[16] The greater productivity may be expected to shorten further the already shrinking work-week. It has been predicted that the average work-week, which dropped from about 66 hours in 1870 to around 40 hours in 1950, may well fall to 35 hours or even to 30 hours in the not distant future.

Automation and Maintenance of Job Opportunities

Automation enthusiasts vigorously deny that automated factories will be workerless factories. They contend that, although automation may reduce the need for unskilled workers, it will increase the need for skilled and professional personnel. Some of the atomic plants at Oak Ridge, for example, are reported to be run by "20 or 30 girls" but to be serviced by hundreds of maintenance men.[17] H. W. Martin of Rensselaer Polytechnic Institute told an automation conference sponsored by the New York state department of commerce last May that "Automation will tend to generate an increased demand for highly trained scientists and engineers, and for skilled mechanics with specialized training in the adjustment, maintenance, and repair of . . . complex electrical, mechanical, electronic, hydraulic, and pneumatic apparatus."

Automation was responsible for a 25 to 30 per cent re-

[16] A visitor to a Gary, Ind., steel mill reported that use of a new continuous annealer there had enabled the mill to break production records and at the same time give its workers long rest intervals. "The men prize beyond measure this new work life . . . that allows them to leave in the evening ready for work or fun at home instead of shaking and frustrated with exhaustion."—Warner Bloomberg, Jr., "The Monstrous Machine and the Worried Workers," *The Reporter*, Sept. 29, 1953, pp. 30-31.

[17] John Diebold, "Automation and Jobs," *The Nation*, Oct. 3, 1953, p. 271.

duction in so-called direct labor at the Ford engine-block plant, but the addition of other labor in part canceled that reduction. Other plants have reported that whereas *before* automation operators made up 70 per cent of the labor force and maintenance men 30 per cent, *after* automation the figures were likely to be 55 per cent for operators and 45 per cent for maintenance men.

It has been contended that automation will not produce unemployment because it will tend to up-grade unskilled or semi-skilled laborers into more skilled jobs rather than to displace them. The ease of such a transition would depend, of course, on how rapidly and how successfully the labor force could be retrained. "If such up-grading were to fall behind the demand of the changing technology," Wassily Leontief has written, "semi-skilled and unskilled workers certainly would suffer unemployment or at least sharply reduced earning power." [18]

Although automation may cause a certain amount of temporary unemployment, it is asserted that expansion of the economy—made possible in part by automation—will soon restore full employment. The more goods that are produced, runs this argument, the more the workers who will be required in the fields of distribution and services. At the Admiral Corporation, instead of displacing personnel, automation is reported to have increased production to such an extent that more workers have been hired. And in the telephone industry, the actual or threatened displacement of about 50,000 operators, as a result of installing local dial systems, was offset by a general expansion of employment in the wake of a phenomenal growth in the demand for telephone service.

John Diebold has contended that automation's "probable impact upon the economy has been greatly exaggerated," and that "the proportion of the economy . . . [which] will be affected . . . is far smaller than most of the published predictions." Diebold based his opinions on the assumption that "contractions in one function will tend to be offset by expansions in other functions." He pointed out also (1) that manufacturing, which is most affected by automation, employs only one-fourth of the total labor force; (2) that automation is possible only in certain types of manufacturing; and (3) that even in automated offices there will

[18] Wassily Leontief, "Machines and Man," *Scientific American*, September 1952, p. 156.

have to be human workers to answer letters and "tape" [instruct] the machines.[19]

Fears of Widespread Technological Unemployment

Not all of those who have looked into the problem are so hopeful. The authors of a study made for the C.I.O. Oil Workers found that the number of production workers in the highly automated oil-refining industry fell from 147,000 to 137,000 between 1948 and 1954. A report on automation, prepared for the C.I.O. United Automobile Workers' Economic and Collective Bargaining Conference last autumn, said that full automation would "mean . . . that 200,000 men could match the present output of the million U.A.W. members in the automobile industry."

Although it has been contended that, in general, up-grading will prevent displacement of workers by automation, some skepticism on that score has been indicated. Gordon Brown of the Massachusetts Institute of Technology, for example, told the United Steelworkers convention last September that he had heard "too little about how the worker who is displaced moves into the up-graded job." [20] A local union official at a Gary steel mill had complained a year earlier that there was "little or no attempt to train the older men to take these new jobs." [21] Reports have been circulated that skilled workers whose tasks have been largely taken over by machines have been, not up-graded or even retained on the same pay basis, but down-graded into semi-skilled or unskilled jobs.[22]

Measures Proposed by Labor to Protect Workers

Until both management and labor have had more experience with automation, it will continue to be a question whether it is something to be feared or welcomed. Labor in the meantime is reserving judgment. It recognizes that automation may be a great boon to the working man as well as to industry, but it insists that precautions must be taken

[19] John Diebold, "Automation—The New Technology," *Harvard Business Review*, November-December 1953, pp. 64, 69-70.

[20] Brown suggested "widespread use of on-the-job training, well in advance of the introduction of a new automatic process or technique."

[21] Quoted by Warner Bloomberg, Jr., "The Monstrous Machine and the Worried Workers," *The Reporter*, Sept. 29, 1953, p. 29. Bloomberg said that company supervisors, on the other hand, complained that union seniority rules prevented use of young, better educated men to operate some of the new steel-making machines.

[22] The C.I.O. Shoe Workers union has opposed payment of semi-skilled or unskilled wage rates for jobs previously classified as skilled but proposed for down-grading because of introduction of improved machinery.

to see that the eagerness of industry to reap immediate profits from automation does not jeopardize the present status of workers or the long-run gains in prospect for both workers and industry. A resolution adopted by the C.I.O. convention at Los Angeles last month said:

> Responsibly controlled in the interests of human welfare, the new technology can not only make possible a vast improvement in the material standards of living of all the people, including a rapid rise of living standards in the underdeveloped areas, but can permit at the same time an increase in human leisure to enjoy the new abundance. Irresponsibly introduced and exploited, it can result in unprecedented unemployment and an economic depression which may threaten the very foundations of our free society.

The earlier report of the U.A.W.'s Economic and Collective Bargaining Conference had observed that "The possibility of dramatic technological advances emphasizes the need for an expanding economy built upon the broadest possible purchasing power base." The report noted that automation would increase productivity and asserted that "Increased productivity without increased total production is a formula for depression." Consequently, it said, "Workers must be assured of a rising, steady income to buy the goods which the robot machines can produce." [23]

C.I.O. President Reuther, in his annual report in December 1954, called for immediate action to prevent automation from causing mass unemployment and depression. To help purchasing power keep pace with increases in industrial productivity, Reuther advocated such general measures as the guaranteed annual wage, an increase in the statutory minimum wage, an increase in personal income tax exemptions, and liberalization of social security benefits.

The U.A.W.'s report had urged such specific steps, in industries affected by automation, as changes in seniority rules to give workers the right to move into new, automated operations; inclusion in labor contracts of provisions requiring preferential hiring of workers laid off by installation of new equipment; retraining at company expense of workers whose old skills are no longer needed; and granting of pay increases to workers in the new, more responsible jobs.

[23] "Automation Makes Guaranteed Wage a Must!" *United Automobile Worker*, December 1954, p. 11.